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MATHEMATICAL MODELING FOR THE PREDICTION AND OPTIMIZATION OF LASER HAIR REMOVAL

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The purpose of this study was to develop a mathematical model of hair growth based on the known facts regarding the hair cycle and the effect of laser on hair. Hair removal is most often a multiple treatment process which may take months if not years. It is not unusual for treatment results to be somewhat inconsistent and unpredictable. A large number of parameters need to be taken into account in order to understand and optimize the treatment procedure.

The long term study of human and animal hair has resulted in significant knowledge of the temporal and regional behavior of hair growth. In the past few years, a better understanding of the laser hair removal process has also emerged. The fusion of this information allowed us to develop a consistent mathematical description of laser hair removal based on the available experimental facts. The model uses input data such as the duration of anagen and telogen, the efficacy of an individual laser treatment, the time interval between treatments and the number of treatments in order to predict the short and long term outcome of hair removal. By comparing the clinical with the mathematically predicted results, the model can be tested, modified and used to optimize the procedure.

In this study, the capacity of the model to predict the results of laser hair removal with the Q-switched Nd:YAG laser is demonstrated. The model closely approximates the clinical data from various body sites after single or multiple laser treatments.

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REDUCTION OF REGROWING HAIR SHAFT SIZE AND PIGMENTATION AFTER RUBY AND DIODE LASER TREATMENT

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Laser pulses which selectively damage pigmented hair follicles are a useful treatment for hypertrichosis. Clinically, regrowing hairs are often thinner and lighter after treatment. In this study, hair shaft diameter and optical transmission were measured before and after ruby (694 nm) and diode (800 nm) laser irradiation. Hair was collected from 47 and 41 subjects treated with ruby (0.3 ms and 3 ms) and diode (10-20 ms) lasers, respectively. "Responders" were defined as subjects with significant long-term hair loss, *i.e.*, < 80% of baseline hair count at 9 and/or 12 months after treatment. In ruby laser responders (34/47), regrowing hairs were significantly thinner and lighter. However, regrowing hairs were lighter, but not thinner in "nonresponders" (13/47). The regrowing hair shaft absorption coefficient was significantly decreased in the group treated with 0.3 ms ruby, but was not changed by 3 ms ruby or diode laser treatment. After diode laser, 38 of the 41 subjects were responders and regrowing hairs were thinner and lighter. These results show that lasers can affect either structural recovery (size of hair), follicular pigmentation (hair absorption coefficient), or both. Laser-induced reduction of hair diameter and/or pigmentation are long-term responses which confer cosmetic benefits in addition to actual hair loss.

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LONG TERM EFFICACY OF NORMAL-MODE 694 NM RUBY LASER AND 800 NM DIODE LASER FOR HAIR REMOVAL.

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To evaluate the importance of fluence and number of treatments on the long term efficacy for hair removal using ruby and diode lasers. Eighty subjects were treated in our laboratory with a ruby laser (Palomar Epilaser, 694nm) 3 msec, 7 or 10 mm spot size and fluences ranging from 10 to 70 J/cm2 or a diode laser (Star Lightsheer, 800nm) 5 to 30 ms, 9 x 9 mm square spot size and fluences from 10 to 40 J/cm2. The number of treatments ranged from 1 to 8, on different body sites using variable fluences. Efficacy was assessed by blinded grading according to an established scale. For both lasers results were fluence-dependent with permanent hair removal occurring at fluences $\geq$ 30 J/cm2. The ruby laser exhibited greater efficacy at inducing temporary hair loss than the diode laser, however, the diode laser showed greater efficacy for thick and course hair. Both lasers had better efficacy after 3 or more treatments. Approximately 80 % of the patients had significant hair loss after 3 treatments with the diode laser and 70% after 3 treatments using the ruby laser. Transient pigmentary changes were observed. There were no incidents of scarring. Ruby and diode lasers are safe and effective for long term hair removal with an accumulative effect after multiple treatments, as well as an increase in efficacy using higher fluences.

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LASER HAIR REMOVAL WITH A MILLISECOND Q-SWITCHED ND:YAG LASER.

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Laser hair removal has been attempted with nonosecond and millisecond systems. The nanosecond Q-switched Nd:YAG laser, used with and without carbon adjuvant, causes mechanical disruption of the hair without inducing thermal damage. However, it may be this thermal damage, seen with millisecond laser systems that leads to improved long term hair reduction. Conversely, the 1064 nm Q-switched Nd:YAG wavelength is less damaging to pigmented skin than the millisecond visible light melanin absorbing wavelengths. This study was designed to evaluate the hair removal efficacy of a new millisecond Q-switched Nd:YAG laser.

15 subjects with unwanted facial or non-facial hairs were treated with a 30 millisecond Q-switched Nd:YAG laser. Fluences used were 100 J/cm$_2$ for facial hair and 130 J/cm$_2$ for non-facial hair. Hairs were clipped prior to laser treatment and then treated with a cooled scanning device. Treated areas were compared to non-treated adjacent sites. All subjects were evaluated at 1 week,

1 month and 3 months after laser treatment.
All subjects showed decreased hair counts at treated sites. Neither scarring nor pigmentary changes were noted in any individual.

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HAIR REMOVAL WITH LONG-PULSED ALEXANDRITE LASER FOR PATIENTS WITH SKIN TYPES III-VI

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Long-term hair reduction has been demonstrated with a variety of millisecond-duration pulsed red and infrared lasers and light sources, but pigmentary alteration is a concern in patients with darker skin types. The purpose of this study was to determine the efficacy and safety of a 3msec duration pulsed alexandrite (755nm) laser in patients with darker skin (skin types III-IV).

Twenty patients with dark hair and skin types III-IV underwent a single treatment with a 755nm, 3msec alexandrite laser at fluences of 10-20J/cm^2. This laser was used with cryogen spray cooling to provide protection of the epidermis from thermal injury during laser irradiation. Therapeutically optimal fluences and cooling device parameters were chosen based on dose response curves determined in this study.

Follow-up evaluations at 1, 3, and 6 months after treatment were done. Efficacy was determined based on hair count evaluations. The incidence of adverse effects, including hypopigmentation, hyperpigmentation, and scarring was noted.

The potential advantages of using the long-pulsed alexandrite laser with cryogen spray cooling for hair removal on subjects with darker skin types are discussed.

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THE 3 MILLISECOND LONG PULSE ALEXANDRITE LASER FOR HAIR REMOVAL.

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The purpose of this study was to evaluate the efficacy and safety of a long pulse alexandrite laser (GentleLase, 755nm, 3msec, Candela Corporation) for hair removal. 75 patients with skin types I to IV were included in the study. Patients had comparable areas shaved, and then used as a test site, treatment area or control. Fluences between 20 and 40J/cm^2 were delivered through an optical hand piece with a 10mm spot size. A cooling spray of tetrafluoroethane of 50 msec duration and 2 msec delay was used to protect the epidermis.
All patients received one treatment, and were followed at one, four and twelve weeks (some patients were also evaluated at one year). At each visit, hair counts and diameter measurements were obtained. Patients were also assessed for the presence of epidermal damage, pigmentary changes, or scarring.
Three months follow-up data was available on 43 patients at the time of the abstract. Minor superficial crusting related to high fluences was seen in 5 patients, and was healed by one week. Mild erythema lasting for more than seven days occurred in 5 patients. Minimal hyperpigmentation resulted in 6 patients and resolved in five at the 4 week follow-up. No hypopigmentation or scarring was seen. At three months, average hair counts were reduced from 16.6cm^2 to 9.3cm^2 (mean reduction: 7.3cm^2, $p<0.001$), and average hair thickness was reduced from a mean of 0.66mm to 0.46mm (mean reduction 0.20mm, $p<0.001$). This is the first study done on this laser system and demonstrates that the 3 msec long pulse alexandrite laser is safe and effective when used for hair removal.

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LONG TERM DATA ON THE USE OF THE LONG PULSED ALEXANDRITE LASER FOR THE TREATMENT OF BIKINI HAIR: A 12 MONTH FOLLOW UP

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PURPOSE: This study was designed to evaluate the use and efficacy of the Long-Pulsed InfraRed (LPIR) laser for the treatment of unwanted bikini hair.
METHODS: Fifteen patients were treated at three week intervals for a total of four treatments with the LPIR laser (Cynosure, Inc. Chelmsford, MA). The laser parameters were held constant for all patients and treatments. The 10 mm spot size was used to deliver 20 Joules of energy with a 20ms pulse duration. Results were evaluated one year after the last laser treatment for clinical reduction in hair using the following rating scale: poor (0-25%); fair (26-50%); good (51-75%) and excellent (76-100%).
RESULTS: All patients demonstrated a marked reduction in bikini hair at one year follow up. There was no evidence of scarring. Transient pigmentary changes were seen in a few patients initially however, at one year follow up, no evidence of pigmentary change was noted.
CONCLUSIONS: The use of the Cynosure LPIR laser is a safe and effective way to permanently remove unwanted bikini hair.

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Hair Reduction with a Very Long Pulse Infrared Diode Laser.

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Purpose: To prospectively evaluate the clinical safety and efficacy of a low power, continuous wave long pulse infrared diode laser system for the purpose of hair reduction.
Methods: Ten patients were prospectively evaluated in this pilot study. Skin types I – III were evaluated. Each participant received treatment on the upper lip or leg with continuous wave irradiance of 770-840 nm diode laser light at 35 W/cm^2 and 5 second pulse duration with a 1.5 mm spot size. Hair counts were made preoperatively and at three months post-treatment. Digital images were recorded at one week, four weeks, and three months. Physician grading and patient diaries were used to document post-treatment effects.

Results: Initial evaluation showed that hair reduction treatment with a very long pulse infrared diode laser is relatively painless with no significant side effects. Hair count data was not yet available at the writing of this abstract. A detailed evaluation of hair reduction and clinical outcomes at three months and comparison with data from similar wavelength lasers will be presented.
Conclusions: The long pulse continuous wave infrared diode laser is a novel new option for laser hair removal. The relatively low cost and the unit's small size / portability are intriguing. The small spot size and long pulse duration, however, make treatment relatively slow and tedious compared to other long pulse hair lasers of similar wavelength.

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THE SUBJECTIVE AND OBJECTIVE TISSUE EFFECTS OF LONG-PULSED ALEXANDRITE LASER IRRADIATION: COMPARISONS AT 5 AND 20 MILLISECOND PULSE DURATIONS

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PURPOSE: Lasers designed for hair removal produce relatively long pulse durations in order to target hair follicles and spare the epidermis. The present study attempts to determine whether a 20 msec alexandrite laser pulse duration produces less subjective treatment pain and less epidermal trauma than a shorter pulse duration (5 msec) at equivalent energy fluences.

METHODS: Forty subjects with skin types II-V received laser treatments to six, 2x2 cm square patches at the posterior upper arm. Using 755 nm alexandrite laser radiation, three different energy fluences were delivered at either 5 or 20 msec pulse durations. Subjects were asked to rate treatment discomfort and immediate postoperative photographs were taken. Follow-up photographs and examinations occurred at 1 and 3 weeks when treatment sites were evaluated for evidence of dyspigmentation, crusting, blistering, and erythema.

RESULTS: Laser quadrants treated with high energy fluences at a 20 msec pulse duration were rated as being less painful and had fewer side-effects than did those quadrants treated with the same fluence but with a 5 msec pulse width. Test areas receiving low energy fluences were not as affected by pulse width and less differences in treatment outcome were observed between the 5 and 20 msec groups.

CONCLUSIONS: A 755 nm alexandrite pulse duration at 20 msec is less painful and produces less epidermal damage than a 5 msec pulse duration at an equivalent energy fluence. However, it appears that this effect is fluence-dependent: the higher the laser energy the greater the 20 msec tissue-sparing effect observed.

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SHORT PULSE CARBON DIOXIDE LASER RESURFACING OF THE NECK

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The purpose of this study was to evaluate the efficacy of treatment and incidence of complications following short pulse CO_2 laser resurfacing of the neck. Three hundred and eight patients were treated with concomitant face and neck CO_2 laser resurfacing. A 90 microsecond pulse duration CO_2 laser was used on the neck (10.6 micrometer wavelength, 500 millijoules energy, 90 microsecond duration, 3 millimeter spot size). Forty patients who had been treated at least 6 months but no longer than 18 months before were randomly surveyed by phone to assess the degree of improvement in the neck and face. The incidence of scarring and permanent pigmentation changes among the 308 patients was determined during follow-up visits. Of the 308 patients, there were no cases of scarring or permanent pigmentation changes. Surveyed patients reported an average improvement of facial skin of 67% and an average improvement of neck skin of 39% for rhytides and skin tightening. Eighty-five percent of the patients surveyed were pleased with the final results of their laser neck resurfacing. CO_2 laser resurfacing of the neck can be safely performed in conjunction with CO_2 resurfacing of the face, offering patients improvement of neck skin for rhytides and skin tightening, with little chance of scarring or permanent pigmentation change.

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RESURFACING OF THE NECK WITH THE CO2 ULTRAPULSE.

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100 consecutive patients were treated with the CO_2 Ultrapulse for full face resurfacing. In all cases, resurfacing was extended below the mandibular line to the upper 1/3 of the neck, 44 cases extended to mid neck, and 18 cases extended to the clavicle. All cases were treated utilizing topical EMLA anesthesia applied two hours prior to the procedure and occluded with plastic wrap. The CO_2 Ultrapulse was used with the computer pattern generator (CPG) at settings of 300 mJ, 60 watts and the pattern was set at 3 (square) 9 (largest size) and 7 (density) for the face. At the mandibular line the density was dropped to 5 or 6 for one to two rows depending on skin thickness. At that point it was dropped to a density of 4 for one to two rows, 3 for one to two rows, and then a density of 1-2 for the remainder of the neck if the lower half of the neck was treated and the 300 mJ setting was decreased to 250 mJ for the bottom 1/4 of the neck. Patients tolerated treatment with EMLA anesthesia alone very well. Reepithelialization of the neck occurred within one week. Neck erythema correlated with facial erythema and in many cases cleared more rapidly. In no case was a treatment demarcation noted as feathering was very gradual. There were 8 cases of mild hyperpigmentation which cleared with topical hydroquinone, Retin-A, and UVA sunscreen, one case of mild hypopigmentation on the neck that was still present at one year, and no cases of textural changes. Our experience suggests that conservative treatment of the neck with the CO_2 Ultrapulse laser can be successful with good clinical results and few side effects. Most likely the hydration achieved with the use of topical EMLA anesthetic provides some protection from thermal damage. CO_2 laser treatment of the neck should be approached cautiously, especially if EMLA has not been applied.

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TRU-PULSE™ LASER RESURFACING OF PHOTODAMAGED NON-FACIAL SKIN

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Laser resurfacing of the neck and hands has been largely avoided because of the increased risk of scarring in these areas relative to the face. However, novel technology has added to the resurfacing armamentarium lasers with much shallower zones of ablation and residual thermal injury. The Tru-Pulse™ CO_2 laser (Tissue Medical Lasers, Inc., Albuquerque, NM) achieves this technological advantage by using high peak power within an extremely short pulse width (60-125 μsec). By delivering ablative energy an order of magnitude more rapidly than the skin's thermal relaxation time (200-600 μsec), the Tru-Pulse™ leaves considerably less thermal damage than other pulsed or scanned CO_2 lasers, while achieving greater depths of ablation than Er:YAG lasers. Moreover, Tru-Pulse™ patients experience quicker reepithelialization and resolution of erythema than patients treated with other CO_2 lasers to a comparable depth of ablation. These advantages make Tru-Pulse™ conducive to resurfacing non-facial skin, where deep thermal injury would potentiate the higher risk of scarring. We treated 15 subjects with photodamaged neck or hand skin with the Tru-Pulse™ laser, using a 500 mJ pulse scanned over the affected skin with minimal overlap in 1-2 passes. We pretreated with two weeks of tretinoin and, for skin types III-IV, topical hydroquinone. Post-treatment care was achieved with petrolatum and strict compliance with broad-spectrum sunscreens. Patients were assessed and photographed during scheduled 1 week, 2 week, 2 month, 4 month, and 6 month follow-up visits. Pre-treatment and post-treatment biopsies were performed on 4 patients. Overall, patients experienced clinical improvement and few adverse effects.

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THE EFFECT OF A 1320-nm Nd:YAG LASER WITH DYNAMIC COOLING ON HUMAN SKIN. Suchai Sriprachya-anunt, Richard E. Fitizpatrick, Mitchel P. Goldman, Dermatology Associates of San Diego County, Inc., San Diego, CA

Purpose: Pulsed carbon dioxide laser is safe and effective in the treatment of facial wrinkles. However, the immediate postoperative period is often distressing for the patient. The advent of a new Nd:YAG laser (1320 nm) coupling with a dynamic cooling system makes it possible to target dermal collagen with relatively good protection of the epidermal layer. The objective is to investigate if this new laser is effective in inducing collagen tightening and/or neocollagen synthesis without significant damage to the overlying epidermis.

Method: Three to four areas of 10 mm x 10 mm were marked on either inner arm or buttock in 10 subjects. Two areas in each subject were tested with a fluence of either 30, 40 or 50 J/cm² with either 1 or 2 coolant spurts of 20-30 ms duration. The other 1 or 2 areas served as controls and were treated with the same coolant spurts with the lowest fluence necessary to activate the coolant spurts. Two of the marked areas in each subject were biopsied after either 2, 14 or 28 days.

Results: Immediately after the laser test, there was no detectable collagen shrinkage. Pain and erythema were common with a fluence of ≥40 J/cm² or double cooling spurts. Wheal and/or induration was observed in only 5 of the 34 tested areas: 1 in the area tested with a fluence of 40 J/cm² and a single coolant spurt and the other 4 in the areas tested with a fluence of 50 J/cm² and 2 coolant spurts. The epidermis was well preserved both clinically and microscopically in all tested sites. Histpathologically, a zone of collagen damage with plump fibroblasts was seen in the dermis, especially with the higher fluences.

Conclusion: This study demonstrates the efficacy and safety of the new Nd:YAG laser with a dynamic cooling system. Although no collagen shrinkage was detected in this study, the presence of apparently activated fibroblasts might lead to new collagen synthesis.

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NONABLATIVE CUTANEOUS LASER RESURFACING: A CLINICAL AND HISTOLOGIC ANALYSIS

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PURPOSE: To investigate the clinical effectiveness and histologic findings of a non-ablative, solid state pulsed Nd:YAG laser for facial resurfacing.

METHODS: Patients with mild facial rhytides (periorbital, cheeks, perioral) were resurfaced with a 1.32 *u*m pulsed Nd:YAG laser with simultaneous cryogen delivery by a single operator. Clinical effectiveness of treatment and presence of side effects were determined by sequential photographic analysis at 0.5, 1, 2, 4, 12, and 26 weeks postoperatively. Skin biopsies for histologic analysis were obtained prior to, immediately after laser resurfacing, and at 26 weeks postoperatively.

RESULTS: Minimal clinical improvement was seen immediately after treatment. Progressive, slow improvement of skin texture and degree of wrinkling were noted throughout the 26 week postoperative period. Side effects were limited to transient erythema. Histologic changes were slight with mild increase in collagen content observed at end-study.

CONCLUSION: A solid state pulsed Nd:YAG laser at 1.32 *u*m produces gradual clinical and histologic improvement of facial rhytides with minimal side effects.

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NON-ABLATIVE IMPROVEMENT OF SUPERFICIAL RHYTIDES WITH LONG-PULSED, NON-COHERENT, INTENSE PULSED LIGHT TREATMENT. David J. Goldberg, New Jersey Medical School and Skin Laser Center, Pascack Valley Hospital, Westwood, New Jersey.

Laser treatment of rhytides usually requires epidermal ablation. Such ablation requires time off from daily activities during the healing process. Non-coherent, intense pulsed light can be emitted at a variety of different wavelengths. This study was designed to determine if an intense pulsed light source can be effective in the non-ablative treatment of fine rhytides.

20 subjects with Class I periorbital rhytides received 1-3 sessions of long pulsed, non-coherent, intense pulsed light treatment. Subjects were evaluated for both clinical improvement and incidence of complications.

10 subjects showed significant improvement; 7 subjects showed mild improvement; 3 subjects showed no improvement. Transient erythema occurred in all subjects. No scarring or long-term pigmentary changes were noted.

Long-pulsed, non-coherent, intense pulsed light treatment can improve superficial rhytides in a non-ablative manner.

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NON-ABLATIVE SKIN REMODELING: SELECTIVE DERMAL HEATING USING AN IR LASER WITH SURFACE COOLING. EV Ross, FP Sajben, JR McKinlay, CH Miller, DJ Barnette, J Hsia*.

Department of Dermatology. Naval Medical Center San Diego, and Candela Corp., Wayland MA*. The purpose of this study was to examine the effects of a non-ablative resurfacing system. The system was comprised of an erbium glass laser (1.55 μm) with a 5 mm spot coupled to a conductive cooling window. Nine patients participated in the study. Each patient received laser treatments at six tattooed postauricular sites. One side was treated with 1 pass of the laser. The other side was treated with two passes with identical heating and cooling parameters. Patients were followed weekly for one month, and finally at two months. Immediately postop, sites showed varying degrees of erythema, edema, and in some instances, epidermal whitening. Thresholds for epidermal whitening and subsequent scarring were pulse energy and pulse number dependent as outlined in the table. For pulse energy/pulse number combinations which did not exceed this threshold, there was erythema and edema which persisted for 2- weeks, after which these sites were grossly indistinguishable from untreated skin. Biopsies immediately post op showed epidermal preservation and slight tinctorial changes in collagen staining from 500-1500 μm deep in the dermis. Two-month biopsies showed fibroplasia zones roughly corresponding to these initial zones of heat induced changes. We conclude that a deeply penetrating IR laser coupled with surface cooling is capable of selective dermal heating with new collagen deposition. Future efforts will emphasize altered cooling and heating parameters to raise the initial zone of heating to 100-400 μm deep in the dermis.

Threshold Values for Atrophic Scar Formation

Precool time/Temp	Hz	Pulse energy	# pulses
2 sec, 0°C	8	400 mJ	40
2 sec, 0°C	8	600 mJ	25
2 sec, 0°C	8	800 mJ	12
2 sec, 0°C	8	1000 mJ	7

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SKIN RESURFACING WITH A COMBINED ERBIUM:YAG AND CARBON DIOXIDE LASER. David J. Goldberg, New Jersey Medical School and Skin Laser Center, Pascack Valley Hospital, Westwood, New Jersey.

Carbon Dioxide (CO_2) lasers are highly effective systems for the treatment of sun-damaged skin. Mechanisms of improvement include laser-induced ablation; dermal wounding and remodeling; and thermal contraction of dermal collagen. Such lasers cause significant wounds and occasional prolonged erythema. The Erbium:YAG (Er:YAG) laser also leads to cosmetic improvement without inducing a significant thermal wound. The Er:YAG laser can be used for precise ablation leading to quicker healing with the potential for decreased erythema. However, the Er:YAG laser does not appear to be as effective as CO_2 lasers in treating deeper rhytides. This study evaluated the efficacy of a combined Er:YAG and CO_2 laser. The Er:YAG laser energy was used for precise ablation while the simultaneous CO_2 laser energy was used for its thermal effect.

10 subjects with Class II-III rhytids were treated with a combined Er:YAG and CO_2 laser. All subjects were treated with the Er:YAG laser at 24 j/cm^2. Simultaneously, CO_2 laser energy was delivered with 2-3 watts and a 50% duty cycle. Representative biopsies were undertaken. All treatments were delivered through a computerized scanner. Subjects were evaluated for clinical improvement, scarring and pigmentary changes at one week, one month, three months and six months.

All subjects showed clinical improvement. Neither scarring nor pigmentary changes were noted at six months.

A laser that emits both Er:YAG and CO_2 laser wavelengths may provide the simultaneous benefits of each system.

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CUTANEOUS RESURFACING WITH DUAL MODE ERBIUM:YAG LASER

Christopher Zachary, University of California, San Francisco

Purpose: This presentation will examine the Sciton Contour Er:YAG laser with its dual mode ablation/coagulation capabilities.

Methodology: Thirty patients with chronic photo-aging have been treated with the above mentioned laser system. In these, resurfacing was performed with either pure ablative (10-30J/cm^2) mode or combined ablative and coagulative (2J/cm^2) modes.

Results: Superficial laser abrasion was achieved successfully with either single mode (ablation) or dual mode (ablation with coagulation). Deeper vaporization with single mode ablation (no coagulation) was universally associated with bleeding which became more exaggerated with successive passes. Dual mode (ablation plus coagulation) achieved any desired depth of vaporization with bleeding that was minimal. This mode resulted in visible 'contraction' of tissue. As with other Er:YAG lasers, there was no typical 'end-point' or chamois discoloration associated with desiccation. Pain, erythema, and final end-point of healing were intermediate between Er:YAG and high energy short pulse CO_2 laser resurfacing. Good to excellent rejuvenation was observed in the majority of patients. Though scarring was induced in one patient with an Er:YAG laser, none of the Sciton Er:YAG patients resulted in scarring. (This was probably a technique dependent, learning curve response.)

Conclusions: There is a significant difference between the single mode standard Er:YAG resurfacing lasers and the dual mode system used in this open study.

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SIDE-BY-SIDE COMPARISON OF CO_2 AND ERBIUM LASERS USING A MINIMALLY INVASIVE TECHNIQUE. EV Ross, CH Miller, JR McKinlay, FP Sajben, DJ Barnette, KJ Meehan. Department of Dermatology, Naval Medical Center San Diego, CA 92134. This study's purpose was to determine if equivalent injuries could be produced by multiple passes of an erbium laser and one pass of the CO_2 laser. Fourteen patients participated in the protocol. For each patient, 1 side of a cosmetic unit was treated with a Nidek Vitalase erbium laser with the following parameters: fluence = 5 J/cm^2, 4 passes, 350 μsec pulse duration. The contralateral side was treated with the Nidek Unipulse CO_2 laser: Fluence = 12 J/cm^2, 1 pass, pulse duration 0.5 msec. Wiping with wet gauze was performed on the CO_2 treated side in 11/14 patients. In the remainder of the CO_2 sites and all of the erbium treated sites, no wiping was performed. The erbium and CO_2 sites overall healed similarly; all sites were re-epithelialized by one week. In 7/11 patients where the CO_2 side was not wiped, the CO_2 side showed less erythema than the erbium-treated side after one and two weeks. In the remaining 3 patients, there were no significant differences in erythema. Wrinkle improvement averaged ~ 20% after 6 weeks. Six month follow-up clinical and histological results are pending. Immediate postop biopsies showed no significant differences between depths of injury, as both erbium and CO_2 lasers revealed about 30 μm residual dermal thermal damage and negligible dermal ablation. However, the unwiped CO_2 sites, unlike the erbium and wiped CO_2 sites, showed retained desiccated epidermis. This study showed that one pass CO_2 wounds with post-operative wiping are identical histologically to 4 pass erbium YAG laser wounds for a specific range of laser parameters. One pass CO_2 wounds without wiping, although they achieve the same level of tissue injury as 3-4 pass erbium wounds, heal faster, presumably

because of the natural dressing effect of retained epidermis. The study also showed that wrinkle improvement is minimal for injuries that extend only to the level of the superficial papillary dermis.

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HISTOLOGICAL AND CLINICAL STUDY OF A NEW VARIABLE PULSEWIDTH ERBIUM:YAG LASER. Jason N. Pozner, Aldo A. Lombardo. Jupiter, Florida.

We have evaluated both clinically and through histologic study the characteristics of a new resurfacing technology involving Optical DiaThermy (ODT). This new approach to laser tissue interaction allows for continuously controllable ablation and coagulation of tissue through variable pulsewidth and energy adjustment. The study involved characterization of a new Er:Yag laser by Sciton Inc. incorporating ODT that allows pulsewidths variable from a few 10's of microseconds to 100's of milliseconds. This approach allows traditional short pulse ablation with minimal thermal damage as well as long-pulse coagulation causing controlled thermal damage.

A grid was designed on a patient's abdomen prior to abdominoplasty. The protocol called for single and multiple passes to be performed at varying fluence and number of passes in ablate, coagulate and pulse combination modes. The specimen was excised, placed in formalin and sent for histologic examination by a blinded dermatopathologist.

Results showed that the ablative mode caused precise ablation with minimal thermal damage. The coagulation mode showed good correlation between requested thermal damage depth and measured depth. The pulse combination mode caused variable ablation and thermal damage depending upon fluence and number of passes. Multiple passes in the combined mode did not produce additive results.

Ten patients were then treated using ODT technology. Epithelialization time was 5-7 days with erythema lasting approximately 3 weeks although healing time varied with fluence, treatment mode and number of passes applied. No complications were noted.

Results clearly support the theory that a long pulse coagulation mode with an Er:YAG laser can provide controlled thermal damage to tissue. Further clinical work is needed to determine if long term "CO_2-like" collagen remodeling occurs.

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LONG PULSED (10 MILLISECOND) ERBIUM-YAG AND PULSED CARBON DIOXIDE LASERS IN THE TREATMENT OF FACIAL RHYTIDS. A CLINICAL AND HISTOLOGIC COMPARATIVE STUDY

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Over the past few years mid I.R. Erbium-YAG lasers have been introduced with widely varying and occasionally unsubstantiated claims regarding safety and efficacy in the treatment of photoaged skin. Studies involving comparisons between CO2 and Erbium have been clouded by a lack of histologic equivalence when efficacy, postoperative morbidity and complications were examined. It is clear that issues of efficacy, safety and healing are better understood if equivalent depths of histologic damage are compared. Previous studies have shown greater efficacy when standard pulsed CO2 laser resurfacing was compared to deep Erbium-YAG ablation in the treatment of facial rhytids.

Since equivalent depths of CO2 coagulation and Erbium-YAG ablation failed to produce similar efficacy in the treatment of facial rhytids, one could speculate that thermal injury may play a role in some of the beneficial effects of CO2 lasers. We recently acquired a long pulse (10 msec) Erbium-YAG laser. Histologic studies showed significantly greater thermal effects in the dermis when 10 millisecond and standard 350 u sec pulses of Erbium were compared.

In order to examine the efficacy and comparative advantages of this long pulsed Erbium laser in the treatment of facial rhytids, we entered 14 patients in a bilateral comparative study. Patients were treated using the UltraPulse^R CO2 laser on one side and a long pulsed Erbium-YAG laser on the opposite side. Patients were closely followed postoperatively with careful assessment of duration of erythema, pain, time to re-epithelialization and efficacy. Initial results show that the long pulsed Erbium-YAG laser shows promise in the treatment of facial rhytids.

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THE MICROSCOPIC EFFECT OF THE NANOSECOND CO_2 LASER ON EX VIVO HUMAN SKIN

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The purpose of the study was to evaluate a nanosecond CO_2 laser for thermal effect and ablation depth on human skin. Laser resurfacing with the millisecond CO_2 or Er:YAG instrument has become a popular procedure. The erbium laser has been demonstrated to have a reduced thermal effect and correspondingly shorter post-laser erythema time compared to the CO_2. However, a disadvantage of the erbium is the number of passes necessary to obtain the same smoothing as with the CO_2 laser. An instrument with an effect intermediate between the two would be faster than the erbium, yet heal more quickly than the millisecond CO_2.

A Q-switched CO_2 laser (pulse duration = 130 nsec) was used to irradiate ex vivo human skin at a range of fluences. Similar fluences were administered with the millisecond CO_2 and Er:YAG lasers. Specimens were placed in 10% formalin and stained with hematoxylin and cosin. All histologic specimens were then examined microscopically for extent of thermal damage and depth of ablation.

The Q-switched CO_2 laser demonstrated results intermediate between the other two instruments. The thermal effect was reduced compared to the millisecond CO_2 laser and the depth of ablation per pass was greater than the Er:YAG laser. The nanosecond CO_2 laser may be a useful instrument for resurfacing, causing less thermal damage and resultant erythema than the millisecond CO_2 laser, but requiring fewer passes than the Er:YAG laser for equivalent ablation depth.

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LONG TERM NEO-ELASTOGENESIS AND NEOCOLLAGENESIS FOLLOWING CARBON DIOXIDE LASER SKIN RESURFACING
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This study demonstrates prolific neo-elastogenesis and neocollagenesis as the long term histologic result of CO2 laser resurfacing.

Thirty patients entered this single blinded study. Biopsies were taken preoperatively, six weeks, six months and one year. Hematoxylin & Eosin,

Trichrome, and Elastin Stains were obtained. Two pathology departments evaluated the results. Twenty-two patients completed the study. Transdermal neocollagenesis was noted at six weeks and continued to increase density and organize at six months and one year. Early transdermal neo-elastogenesis became prolific and was confined to the deep dermis at one year.
Prolific transdermal neocollagenesis and deep dermal neo-elastogenesis are demonstrated as a significant long term histologic response to CO2 laser skin resurfacing.

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A CLINICAL AND HISTOLOGIC COMPARISON OF LOW FLUENCE PULSED CARBON DIOXIDE AND ERBIUM-YAG LASERS IN THE TREATMENT OF PHOTOAGED SKIN

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Skin resurfacing using pulsed and flash scanned high energy carbon dioxide lasers has been available for many years. Thermal effects from these lasers within the epidermis and dermis are responsible for both clinical efficacy and postoperative complications such as pigment disturbances atrophic and hypertrophic scarring. Pulsed Erbium-YAG lasers have provided another approach to facial rejuvenation albeit through their ablative properties rather than coagulative mechanisms as seen with CO2 lasers. Studies have shown that when equivalent depth of CO2 (coagulation) and Erbium (ablation) were compared, postoperative pain, erythema and healing time were not significantly different in treatment of periocular and perioral rhytids. In an effort to further examine the role of Erbium and CO2 lasers in photoaged skin, we entered 16 patients in a bilateral comparison study using low-fluence pulsed CO2 energy and pulsed Erbium-YAG laser. Parameters were chosen to provide similar depths of histologic coagulative (CO2) and ablative (Erbium) damage. Histologic studies showed relatively similar depths when superficial 100 mJ pattern 6 density CO2 coagulation was compared to 5 pulses(passes) Erbium-YAG at 5.0 J/cm^2.
Results of our studies showed similar postoperative healing time and efficacy when superficial CO2 and Erbium were compared. In addition, there were no significant differences in postoperative results when the neck and hands were treated using these parameters. This study would support the concept that equivalent depths of histologic injury, whether coagulative (CO2) or ablative (Erbium) are associated with similar efficacy and safety in the treatment of photoaged skin.

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PROLONGED CLINICAL AND HISTOLOGIC EFFECTS FROM CO_2 LASER RESURFACING OF ATROPHIC SCARS

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PURPOSE: The purpose of this study was to determine the immediate and long-term histologic and clinical effects of atrophic acne scars after CO_2 laser resurfacing.

METHODS: Forty consecutive patients with acne scarring were enrolled in the study. CO_2 laser resurfacing was performed using identical intraoperative technique and postoperative protocols in each patient. Skin biopsies were taken of scars before treatment, immediately after laser resurfacing, and 1, 6, 12 and 18 months postoperatively in six patients. The degree of residual thermal damage, and collagen/elastin content were determined. Clinical evaluations of all patients were performed from sequential photographs with improvement scores given by two physician assessors blinded to the study protocol.

RESULTS: Significant immediate and prolonged clinical improvement in skin tone, texture, and appearance of CO_2 laser irradiated scars was seen in all patients. Continued collagenesis and subsequent dermal remodeling were observed on histologic examination of biopsied tissue up to 18 months after surgery.

CONCLUSION: Cutaneous CO_2 laser resurfacing provides significant clinical and histopathological improvement of atrophic acne scars that is further enhanced with subsequent collagen remodeling for 12-18 months postoperatively.

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SIMULTANEOUS FACELIFTING AND ER:YAG LASER RESURFACING.

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Laser resurfacing at the time of facelifting can provide a one-stage rejuvenation of multiple facial layers. However, controversy exists about the safety of CO_2 resurfacing over undermined flaps. We theorized that the Er:YAG laser might be as effective, safer and more readily accepted then the CO_2 laser combined with facelifting.
Since January, 1997 we have performed 93 facial rejuvenative procedures with combined simultaneous Er:YAG facial resurfacing. 53 patients had endoscopic forehead lifts, 11 patients had endoscopic forehead and subperiosteal midface lifts and 15 patients underwent endoscopic forehead lifts and biplanar facelifts (midface and subcutaneous facelift). 40 patients had subcutaneous facelifts with SMAS plication. All patients underwent full face high fluence resurfacing with a variety of Er:YAG lasers following their facial procedures. All patients underwent the same "closed" post-operative laser regimen.
There were no major complications noted. Three patients had synechia of the lower eyelids that were treated by cutting the adhesion. No infections were noted. Average time to healing was 7 days. Redness lasted on average 3 weeks.
We conclude that combined facelifting and Er:YAG full facial resurfacing can provide a safe one stage facial rejuvenation in most patients. However, we caution readers that combined techniques only be attempted by experienced laser practitioners.

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SILK TOUCH LASER DEEPITHELIALIZATION IN RESIDENT EDUCATION

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Free hand laser deepithelialization has been shown to produce a uniform and bloodless dermal pedicle when used for breast reductive surgery. However, free hand CO2 deepithelialization remains a difficult concept to teach residents. Hand speed and accuracy can vary with experience causing the novice to over

penetrate tissue resulting in unnecessary thermal damage. Silk Touch deepithelialization provides an excellent method for increasing safety while providing a means of educating residents in the art of free hand laser technique. All residents in our two year training program participate in a one day animal lab to introduce them to laser surgery. The initial lesson in clinical training is controlled vaporization of the skin. The goal is to utilize high power with a short exposure time to decrease thermal injury. The creation of a dermal pedicle during breast reduction surgery provides a model for developing these skills.
50 breast reduction were performed at our teaching hospital using inferior pedicle technique. All pedicles were deepithialized using a CO2 laser with a 125 mm handpiece defocused to a spot size of 3-5mm at 60 to 120 watts. During the last 8 months the Silk Touch modality was employed exclusively. Patients were followed for complications. Histologic sections were taken from patients to evaluate the depth of thermal injury with each technique.
Four plastic surgery residents participated in the study. Operator time improved significantly over 10 cases. Residents were able to advance to higher powers more quickly with Silk Touch (120 watts) when compared to the standard defocused technique (60 watts). There were no complications. Histologic sections revealed uniform deepithelialization with 0.15mm of damage into the papillary dermis with Silk Touch technique. Deeper injury was seen with the free hand technique, often extending into and beyond the superficial vascular plexus. As laser surgery becomes more prevalent within residency training programs, formal educational formats will need to be developed. The Silk Touch modality provides a safe teaching tool for the novice laser surgeon, while providing an efficient and bloodless technique for deepithialization.

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ERBIUM:YAG LASER FOR THE TREATMENT OF ACTINIC KERATOSES

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There is no single optimal treatment for multiple facial actinic keratoses. The existing therapies such as topical 5 fluorouracil or chemical peels can produce prolonged recovery time and unpredictable results respectively. The purpose of this study is to investigate another therapeutic modality which has a shorter recovery time and more uniform results. We performed a prospective study investigating the use of the Erbium YAG laser for the treatment of multiple facial actinic keratoses.
Five patients with multiple facial actinic keratoses were treated with two to three passes of Erbium YAG laser. Anesthesia was achieved in all cases by topical means. All patients were treated with 2.0 J, 5 mm spot size, fluence of 10 J/cm^2. Clinical and histologic evaluations were performed both pre- and postoperatively.
All patients showed a decrease in the total number of clinical actinic keratoses on the face. Re-epithelialization occurred between 5 to 8 days, and erythema lasted for about 3 to 6 weeks after the procedure. There was no evidence of scarring or pigmentary changes in any of the patients.
Erbium YAG laser is a safe and effective treatment for multiple facial actinic keratoses with a relatively short recovery period. In addition, it has a low risk of scarring and can be performed as an outpatient without intravenous anesthesia. Unlike the CO_2 laser, Erbium YAG laser treatment can be performed with topical anesthesia alone.

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MANAGEMENT OF HYPERTROPHIC SCARS, KELOIDS AND SCAR CONTRACTURES WITH ER:YAG LASER

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Purpose: To present management of hypertrophic scars, keloids and scar contractures of different etiologies with Er:YAG laser; 5 years of experience.

Methods: Er:YAG laser (Fotona SkinPlus) was used to treat the hypertrophic scars, keloids and scar contractures. The scars were irradiated with energy density 10-25 J/cm^2 and frequency 6-10 Hz. The ablation mode was used until bleeding appeared. The wounds were covered with steroid ointment. The treatment was repeated after 1-2 months. For some patients 4 or more procedures were required. Some scars were histologically examined several months after the laser irradiation.

Results: After Er:YAG laser treatment remarkable regression of scarring tissue was observed. Epithelisation was completed in 7-10 days, redness persisted up to 5 weeks. Histological picture revealed dissapearing of hialine areas of collagene connective tissue, replaced with ortotopic collagen connective tissue, with scanty remaining elastic tissue. After 5 years of observation, there is no evidence of scar recurrency.

Conclusions: Hypertrophic scars, keloid and scars contractures can be successfully removed with Er:YAG laser.

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TREATMENT OF STRIAE DISTENSAE WITH A 132. NM ND:YAG LASER

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The 1320 nm Nd:YAG laser with cryogen spray cooling device has recently been shown to improve periorbital rhytides by stimulating new collagen growth through thermal stimulation. This study was undertaken to evaluate the effectiveness of this laser system in the treatment of both mature and immature striae distensae.

Thirty volunteers with Fitzpatrick skin types I-III and with mature or immature striae distensae were selected to participate in this study. The striae were treated in three consecutive visits 3-4 weeks apart with 1320 nm Nd:YAG laser with cryogen spray cooling at fluences of 30-48 J/cm^2. The striae were reevaluated at each treatment session and at follow-up visits at 3 and 6 months post treatment. Serial photography and silicone impressions of the surface contour were obtained at each visit for treatment evaluations.

This study evaluated the effectiveness of the 1320 nm Nd:YAG laser with cryogen spray cooling in the treatment of mature and immature striae distensae.

The 1320 nm Nd:YAG laser with cryogen spray cooling device is an effective therapy for striae distensae due to the thermal stimulating effects on collagen with relative sparing of epidermal injury.

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FULL FACE LASER RESURFACING UTILIZING TOPICAL ANESTHESIA ALONE

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Laser resurfacing is often done under IV sedation or even general anesthesia. We present 100 consecutive full face laser resurfacing patients (93 women, 7 men) who were treated with topical anesthesia utilizing EMLA. 91 cases were performed for sun damage and rhytids and 9 patients were treated for acne scarring. Of the 100 patients, only 4 required additional local injections for anesthesia. Proper use of topical EMLA is critical for success. The patient first washes with hot, soapy water and then applies hot compresses for 10 minutes. The face is then dried and a full 30 gm tube of EMLA is immediately applied and occluded with plastic wrap. 1 1/2 hours later a second tube of EMLA is added to cover any areas where the EMLA has soaked in to ensure sufficient coverage of all the areas. 1 to 2 Vicodin and 5 to 10 mg of Valium are also given at that time. Two hours after the initial application of EMLA patients are treated with the CO2 Ultrapulse with the computer pattern generator (CPG) set at 300 mJ and 60 watts. The pattern for the first pass is set at 3 (square) 9 (largest size) and 7 (density). The face is treated in quadrants with removal of the EMLA and the first pass done immediately at that time. A second and possibly even a third pass is done immediately afterwards at lower densities as clinically indicated before moving on to the next quadrant. Most patients were comfortable during treatment. In 4 patients infraorbital and mental nerve blocks were utilized for improved anesthesia. In nearly all cases, patients reepithelialized by 7 days and in no case did it take longer than 8 days. In addition, the hydration from EMLA appears to decrease thermal damage. In conclusion, EMLA not only provides safe anesthesia but may also decrease the risk of side effects with CO_2 laser resurfacing. Other topical anesthetics are being explored.

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COMPARATIVE STUDY OF FOUR TOPICAL ANESTHETICS

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With the emergence of new lasers and filler substances, the need for more effective topical anesthetics continues to grow. In order to compare the degree and duration of anesthesia produced by various topical anesthetics, we performed a prospective, pilot study investigating the efficacy of EMLA (Astra Inc.), ELA-max (Ferndale Laboratories, Inc.), 4% Tetracaine (University Pharmacy, Salt Lake City, Utah), and Betacaine LA Ointment (formerly Eutectic, Medical Center Pharmacy, Tampa, Fl).

Equal amounts of the above topical anesthetics plus a control were applied to five test sites (EMLA and 4% Tetracaine under occlusion) on the volar forearm of ten adult volunteers. After 30 and 60- minute application times, the degree of anesthesia was assessed five times by a pinprick apparatus and pulsed dye laser (SPTL 1b, Candela, Wayland, MA). The degree of anesthesia was then tested at 15, 30, and 60-minute intervals after removal of the creams. Volunteer responses to pinpricks were recorded as follows: (0) for no pain and (10) for a sharp sensation. The mean pain score for the different times was obtained.

All of the topical anesthetics used in this study appeared safe and effective, varying in onset, duration, and depth of anesthesia. The lower pain scores correlated with the greater degree of anesthesia. The ideal topical anesthetic should provide full anesthesia in a short time period without side effects. While EMLA is the most commonly used topical anesthetic, the long application time and need for an occlusive dressing are disadvantages. There are now several other topical anesthetics that can be used prior to laser and surgical procedures. All four topical anesthetics were effective, producing an adequate amount of anesthesia in adults.

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USE OF A NOVEL TOPICAL ANESTHETIC FOR LASER RESURFACING.

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The efficacy of a novel topical local anesthetic formula, "Eutectic LA," as the sole source of anesthesia preceding aggressive (3-10 passes) resurfacing with the erbium:YAG laser and mild (1 pass) resurfacing with the UltraPulse/CPG carbon dioxide (CO_2) laser, was assessed in 40 patients. Facial areas to be resurfaced were twice vigorously wiped with an acetone-soaked gauze pad. A thin layer of the anesthetic ointment was applied and left for 15-60 minutes. Immediately before an area was resurfaced, the ointment was wiped off with a gauze pad. After each pass with the laser, the treated area was wiped gently with a cotton-tipped applicator soaked in a buffered solution of 1% lidocaine/ epinephrine 1:100,000. Facial areas treated for rhytid reduction with the erbium:YAG laser included peri-orbital (32 areas), glabella (10 areas), upper lip/ nasolabial (7 areas), chin (6 areas), and forehead (5 areas). Areas treated with the erbium:YAG laser for reduction of scars included the cheeks (14 areas), the nose/paranasal (4 areas) and the pre-auricular (4 areas). The topical anesthetic was used prior to CO_2 laser resurfacing of the upper eyelids (8 areas) and the neck (2 areas). Anesthesia was considered adequate if no supplemental injected anesthetic was needed to complete laser resurfacing. Prior to aggressive erbium:YAG laser resurfacing, use of Eutectic LA resulted in adequate anesthesia in 81 of 86 treated facial areas (94%). Prior to mild CO_2 laser resurfacing, adequate anesthesia was achieved in 10 of 10 areas (100%). Eutectic LA provided adequate anesthesia in nearly all facial areas treated.

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PHOTOACOUSTIC LIGHTENING OR REMOVAL OF TATTOO PIGMENT: A NEW TECHNIQUE UTILIZING Q-SWITCHED LASERS AND TOPICAL CARBON BASED LOTION.

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To evaluate a novel method of removing residual tattoo pigment that has failed to respond to Q-switched lasers. Q-switched Nd:YAG lasers at 532 nm and 1064 nm, Q-switched ruby laser at 697 nm, and the Q-switched alexandrite at 755 nm were used in conjunction with the topical application of carbon based lotion.

25 tattoos with a variety of colors were treated with the aforementioned lasers over one-half of the tattoo while the other half remained as a control with treatment utilizing the Q-switched lasers without the carbon based lotion. Photographic and clinical analysis were performed after each laser treatment to evaluate the potential benefit of this treatment.

The application of carbon based lotion in conjunction with Q-switched laser light can improve the therapeutic outcome of tattoo colors that are resistant to conventional Q-switched laser treatment.

The topical application of carbon based lotion in conjunction with Q-switched laser light is a novel and safe method of improving standard techniques for the removal of tattoos utilizing laser. It is believed that this technique utilizes a photoacoustic mechanism of action.

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IN-VITRO ANALYSIS OF TATTOO PIGMENT RESPONSE TO Q-SWITCHED AND LONG PULSED LASERS

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The response of various color tattoo inks to laser therapy is often unpredictable and irreversible darkening of tattoo inks may occur following laser treatment of some pigments such as iron oxide. The purpose of this study was to analyze the response of a spectrum of tattoo ink pigments to a variety of Q-switched and long pulsed lasers.

A selection of commercially available tattoo inks as well as FDA approved cosmetic tattoo pigments were prepared as 10% w/v or v/v aqueous solutions in 1% agarose and plated in 35 mm diameter plastic petri dishes. Each agarose gel was irradiated with the following lasers: 532 nm (10 nsec), 585 nm (10 nsec), 650 nm (10 nsec), 694 nm (40 nsec), 694 nm (3 msec), 755 nm (300 nsec), 1064 nm (10 nsec).

Several reaction patterns were observed: (a) reflectance of laser light, (b) weak absorption, (c) strong absorption, (d) tattoo pigment darkening, and (e) production of an aura consistent with a 2 photon effect. The millisecond pulse duration lasers did not produce tattoo ink darkening of the pigments that darkened with the Q-switched lasers.

Prediction of tattoo pigment response to laser therapy is possible with this in-vitro agarose gel assay. Analysis of tattoo pigments with this assay may help to standardize the treatment of colored tattoos.

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LASER TREATMENT OF SOLAR LENTIGINES: A COMPARISON OF THREE LASERS AND LIQUID NITROGEN

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Solar lentigines are benign pigmented lesions of the epidermis. Cryotherapy with liquid nitrogen has been the mainstay of treatment for some time, but a prospective trial comparing liquid nitrogen to some of the newer laser systems has not been performed. A randomized, controlled, prospective trial with blinded observers was conducted to compare the efficacy of laser treatment with liquid nitrogen cryotherapy. 8 patients with multiple solar lentigines on the back of both hands were treated. Each hand was divided into two halves, with each half being treated with one of the following four modalities: liquid nitrogen cryotherapy, Q-switched Nd:YAG 532 nm laser, HGM Spectrum K1 laser, and the Diolite 532 laser. Treatment patterns were individually randomized. Photographs were taken before and six weeks following treatment, and blinded observers graded each treatment based on a comparison of the pictures. Additionally, patients were asked to identify their personal treatment of choice. Results show all three laser systems to be superior to cryotherapy with liquid nitrogen. Furthermore, seven out of eight patients preferred laser treatment to cryotherapy. We conclude that laser treatment with the Q-switched Nd:YAG 532 nm laser, HGM Spectrum K1 laser, and the Diolite 532 laser are all superior to cryotherapy with liquid nitrogen for the treatment of solar lentigines.

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FACTORS WHICH AFFECT THE RESULTS IN THE LASER TREATMENT OF CONGENITAL PIGMENTED NEVI

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Since 1997, we have proposed a new protocol for treating congenital pigmented nevi as follows (Osaka Procedure); <1>non-Q-switched Ruby until 50% clearance (usually 3-5 times) <2>Alexandrite until 75% clearance (usually 2-4 times) <3>Q-switched Nd:YAG touch-up (usually 2-4 times) <4>ultrapulse CO2 resurfacing and electric epilation (optional). This serial combined laser treatment enabled complete clearance of large pigmented nevi without excisional surgery.

This time, we analyzed patients who underwent laser treatment of congenital pigmented nevi in our clinic. Four hundred and eighty patients were included in the study. Patient's age, sex, size of the lesion, type of the lesion, procedures done and clinical results are analyzed.

Statistical analysis revealed that patient's age and type of the lesion had a great relation to the clinical results of the treatment. Patients under the age of three showed especially better response to the laser treatment. They required smaller number of treatment and showed better clearance. Thinner, scattered type of congenital pigmented nevi showed better clearance than thicker type. Location and the size of the lesion had a very small relation to the clinical results.

In conclusion, thinner lesions on younger patients require smaller number of treatment, though all of the congenital pigmented nevi can be removed by giving repeating treatment.

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A CONFOCAL MICROSCOPIC STUDY OF PORT WINE STAIN BIOPSIES EXAMINING THE RELATIONSHIP BETWEEN INNERVATION AND VASCULAR SPACE AND TREATMENT OUTCOME

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Purpose: Recent studies have shown that the pathogenesis of port-wine stain birthmarks (PWS) may be related to the lack of innervation seen around the ectatic blood vessels. Using indirect immunohistochemistry and confocal microscopy, we also show deficiency in innervation. We also compared the clinical response of treating PWS to the histological findings and density of innervation.
Methods: Biopsy specimens were taken from two adults with PWS. From each individual, biopsies were taken from the following sites: pre-treatment PWS, post laser (pulsed dye laser) treatment with a poor response, post laser treatment with a good response, and normal skin. All biopsies specimens were investigated with indirect immunohistochemistry using different antibodies to visualize neural fibers and blood vessels. Specimens were then imaged with a MRC-1000 Scanning Confocal Microscope Imaging System(Bio-Rad Life Science) and analyzed using the computer software provided.
Results: The larger (more dilated) the vascular space, the less (if any) innervation seen. In the same lesion (for each individual) there was a difference in the density of innervation. The more responsive the PWS to laser treatment (less dilated ectatic vessels), the more nerve fibers were seen in association with the vascular space. Normal skin showed normal density of innervation around the normal sized capillaries.
Conclusion: The ectatic blood vessels in PWS show a deficiency in innervation. The extent of the deficiency varies within the same lesion and hence the size of the vascular space and hence its responsiveness to treatment with the pulsed dye laser.

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HIGH FLUENCE (11-14J/CM^2 - 7 MM SPOT) LONG PULSED DYE LASER AT 595 NM WITH DYNAMIC COOLING IN THE TREATMENT OF PORT WINE STAINS AND HEMANGIOMAS.

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To evaluate the efficacy of high fluence long pulsed dye laser at 595 nm with dynamic cooling in the treatment of port wine stain and hemangiomas.

50 patients with port wine stains and hemangiomas were treated at significantly higher fluence than has previously been utilized with the pulsed dye laser. These patients underwent treatment with the long pulsed dye laser at 595 nm at energies ranging between 11 - 14J/cm^2 with the 7 mm spot size. The dynamic cooling device was used with each patient with a cryogen application time of 30 milliseconds prior to each laser pulse. Clinical and photographic analysis took place of each lesion following each treatment session and evaluated for percent lightening on a quartile basis and compared to other clinical studies utilizing other techniques. In addition, 10 patients underwent a panel comparison of 10 J/cm^2 vs. 14 J/cm^2 at 7 mm with the cooling device.

High fluence pulsed dye lasers at 595 nm with 1.5 millisecond pulses is safe with a low incidence of side effects and extraordinarily effective.

High fluence pulsed dye laser photocoagulation with 1.5 millisecond pulses and dynamic cooling provides dramatic improvement of port wine stains as well as superficial and moderately thick hemangiomas and should be considered the treatment for the treatment of these lesions.

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PLUSED-DYE LASER (600 NANOMETER, 1.5 MILLISECOND) TREATMENT OF MIXED-TYPE HEMANGIOMAS IN INFANTS.

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Pulsed-dye lasers (PDL) with wavelengths between 577 and 585 nm have been used successfully to treat vascular lesions. For treatment of superficial hemangiomas, the 585 nm PDL has been shown to be safe and effective. However, its success for mixed-type hemangiomas, containing both superficial and deep components, has been limited by its brief pulse duration and short penetration depth. We report the use of the 600 nm/1.5 ms PDL in treating mixed-type hemangiomas. Twelve patients ranging in age from 3 to 12 months (mean 7 months) at the time of presentation were treated prospectively with the 600 nm/1.5 ms PDL (Cynosure VLS, Chelmsford,MA) at 2 to 4 week intervals. Treatment responses were evaluated using a new evaluation scale (Cutaneous Hemangioma Evaluation Scale or CHES) that examined changes in color, surface area, height, epidermal integrity, and growth. The average number of treatments per patient was 4.2 (range: one to 10) over an average time period of 4.1 months (range: one to 11). The fluences used for all cases ranged between 2.8 and 9.0 J/cm2 (mean: 6.1) with either a 7 or 10 mm spot diameter. All twelve of twelve patients showed a positive response. Four patients initially presenting with ulcerations had re-epithelialization of their lesions after only one treatment. One patient experienced post-operative blistering and atrophic scarring after the first laser treatment. Another patient had prolonged discomfort of treatment area, lasting 2 days after the first laser treatment. The 600 nm PDL at the longer pulse duration of 1.5 msec appears to be an effective and safe treatment for mixed-type hemangiomas. Its longer pulse duration over the traditional 0.45 msec PD of the 585 PDL might allow for deeper penetration of energy and coagulation of larger diameter vessels. The Cutaneous Hemangioma Evaluation Scale allowed more objective evaluation of the responses of the hemangiomas to PDL treatments.

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TREATMENT SIDE-EFFECTS UTILIZING THE 1.5 MILLISECOND PULSED DYE LASER IN BOTH ADULT AND PEDIATRIC POPULATIONS

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PURPOSE: The pulsed dye laser has been used at a 450 *us* pulse duration for numerous years and has established an excellent safety and efficacy profile. Recently, a 1.5 millisecond pulsed dye laser was introduced which appears to be as effective as the shorter pulse duration but produces less purpura. The present retrospective study reports the side-effect profile of 200 patients receiving pulsed dye laser treatment at a 1.5 milisecond pulse duration for a variety of cutaneous vascular lesions.
METHODS: A retrospective chart review analysis of 200 patients treated with the 585 nm pulsed dye laser at 1.5 millisecond pulse duration was performed in order to determine the safety profile of this laser system. Subject ages ranged from 9 months to 68 years. Lesions treated included port-wine-stains, hemangiomas, facial telangiectasias, angiomas, warts, striae, poikiloderma, and hypertrophic scars.
RESULTS: Side-effects using a 585 nm wavelength at a 1.5 millisecond pulse duration were similar to those previously reported in the medical literature using the shorter 450 *us* pulsed dye laser. Transient epidermal blistering, crusting, and hyperpigmentation occurred most commonly in less than 2% of treatment sessions. Purpura occurred but in general was less intense and lasted a shorter duration than the 450 *us* pulsed laser system. Even when used to treat infants and children, no scarring or textural changes occurred when delivering similar fluences used with the 450 *us* pulsed dye laser.
CONCLUSIONS: The 1.5 millisecond 585 nm pulsed dye laser is as safe as the 450 *us* pulsed dye laser. No scarring or textural changes were observed when treating a variety of cutaneous lesions, even in children and infants. Less intense pupura and a shorter duration of purpura were noted with the 1.5 millisecond pulse width compared to the 450 *us* laser system.